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ABSTRACT

Developed for use in Technical and Further Education (TAFE) teacher education, this module is intended to widen teachers' knowledge and understanding of the psychology of psychomotor skills to improve teaching of psychomotor skills in the TAFE classroom or workshop. The module is divided into two parts: basic and advanced. The first part, "What are Psychomotor Skills and How Are They Taught?" contains two sections: The Nature of Skills and Skilled Performance, and Teaching Psychomotor Skills in TAFE. The second part, "The Influence of Certain Variables on the Learning of Psychomotor Skills," includes five sections on these variables: Practice, Guidance, Feedback, Methods of Organizing Practice, and Motivation. Each section contains informative material as well as activities and questions for discussion. An appendix provides two class exercises in the form of simple experiments designed to investigate the influence of some of the variables discussed. (YLB)

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ED228406

EDUCATIONAL PSYCHOLOGY FOR TAFE TEACHERS

LEARNING PSYCHOMOTOR SKILLS IN TAFE
(or The Psychology of Psychomotor Skills)

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OUTLINE OF CONTENT

PART A: BASIC

WHAT ARE PSYCHOMOTOR SKILLS AND HOW ARE THEY TAUGHT?

I THE NATURE OF SKILLS AND SKILLED PERFORMANCE

The concept of skilled performance.
Defining skilled performance.
Types or categories of skilled performance (language, perceptual, motor).
Nature and range of psychomotor skills taught in TAFE.
Stages in the acquisition of a psychomotor skill.
Variables important for the development of psychomotor skills.

II TEACHING PSYCHOMOTOR SKILLS IN TAFE

A simplified model for teaching psychomotor skills.
The preparation phase: preparation of teacher, materials and students.
The demonstration phase: provision of guidance.
The practice phase: shaping, perfecting and speeding up.

PART B: ADVANCED

THE INFLUENCE OF CERTAIN VARIABLES ON THE LEARNING OF PSYCHOMOTOR SKILLS

I PRACTICE

Measuring the effects of practice.
Common effects of practice.
Increasing returns. Decreasing returns.
The learning plateau.

II GUIDANCE

What is meant by guidance.
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Some common effects of demonstrations.

III FEEDBACK

What is meant by feedback.
Feedback or reinforcement.
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Knowledge of results.
Some common effects of knowledge of results.

IV METHODS OF ORGANIZING PRACTICE

Part-whole arrangements.
Massed or distributed practice.

V MOTIVATION

Arousing and maintain interest and motivation.

OBJECTIVES

The general objective of this module is to widen teachers' knowledge and understanding of the psychology of psychomotor skills so that they might use this knowledge to improve their teaching of psychomotor skills in the TAFE classroom or workshop.

Specifically, on completion of this module and related classroom instruction, teachers should be able to do the following:

1. Define and describe the general nature of psychomotor skills.
2. Describe the nature and range of psychomotor skills taught in TAFE.
3. Name and describe the three stages in skill acquisition.
4. Name and describe the main variables which influence the acquisition of skills.
5. Describe a simplified model for teaching psychomotor skills.
6. Explain the ways in which the following variables have been found to influence the learning of skills: Practice; Guidance; Feedback; Method of Organizing Practice; Motivation.
7. Describe procedures which can be used in the classroom or workshop to facilitate the learning of psychomotor skills in TAFE.

NOTE

Each section of the module contains activities and questions for discussion and the module is accompanied by two class exercises in the form of simple experiments designed to investigate the influence of some of the variables discussed. These exercises and activities constitute the basis of assessment in the module.

PART A: BASIC

WHAT ARE PSYCHOMOTOR SKILLS AND HOW ARE THEY TAUGHT?

I THE NATURE OF SKILLS AND SKILLED PERFORMANCE

Skilled performance makes it possible for our civilisation to function. We depend on skills such as driving, dressing, running, etc. to get us to work on time in the morning. Every form of sport depends on very specialised and highly developed skills and schools teach basic or primary skills such as reading, writing and mathematical ability.

Technical and Further Education is also very concerned with and dependent on the development of skills. The skills of concern to TAFE are those skills which we generally depend on in earning a living with typewriter, lathe, paint brush, books of accounts, etc. For this reason these skills are usually referred to as practical or vocational skills.

Defining Skilled Performance

Identifying examples of skilled performance is a very much easier task than defining or describing what a skill is.

Jones and Whittaker provide the following definitions of skilled performance drawn from various sources:

> The ability to perform a task as opposed to the knowledge required;
>
> A practical ability or change in behaviour which results from training or experience;
>
> The ability to perform a task to a satisfactory standard;
>
> A complex practical activity that requires the support of theoretical and factual knowledge. (1975, pp8-9)

These authors find the above definitions only partially satisfactory. They point out that skilled performance requires abilities such as manipulation, organisation and direction and develop their own definition of skill as follows:

> A complex goal-directed sequence of activities with a high level of organisation and making extensive use of feedback. (1975, p9)

This definition is sufficient for our purposes.

Types or Categories of Skilled Performance

There are three major types or categories of skilled performance. These are motor, perceptual and cognitive or language skills. (They are set out in table form in Figure 1).

Motor Skills involve extensive use of motor systems and visible movements of the hands or body and range from gross bodily skills such as swimming, running, etc to finer manipulative skills such as filing, sewing, mixing, operating a key punch, loading a paint brush, threading a needle, etc.

Perceptual Skills involve the use of sensory systems and include such abilities as discrimination between various cues, recognition of patterns and symbols, estimation of distance, speed, accuracy, angle, etc.

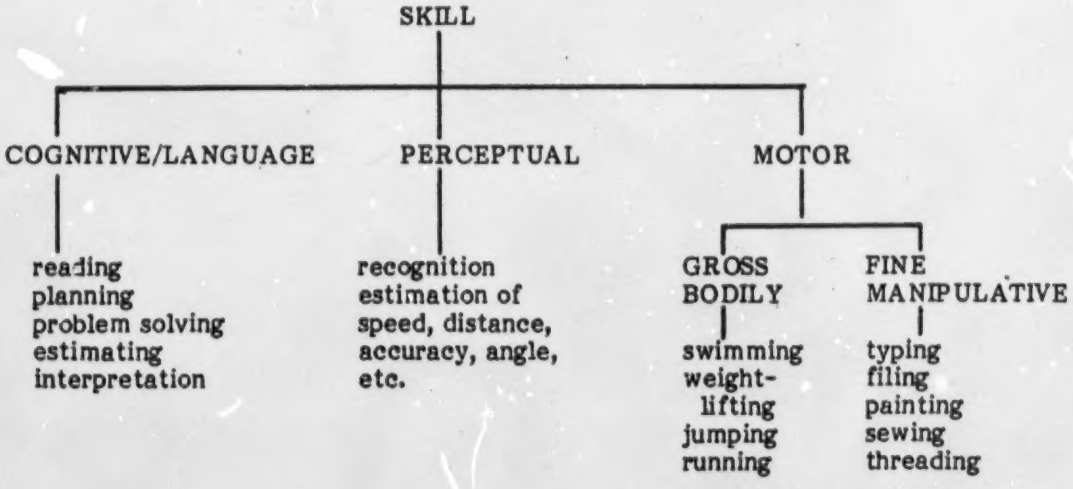
Cognitive/Language Skills involve the comprehension and manipulation of symbols and include such abilities as reading a circuit diagram, interpretation of a drawing or blueprint, solving a calculations problem, preparation of books of accounts, etc.

In actual fact, however, it is rare to find a skill which falls exclusively into one of these categories. Most skills taught in TAFE include all three types or elements of behaviour - it is their relative importance or predominance which varies.

Language and cognitive skills are important, for instance, in the initial stages of motor skill learning, and perceptual skills form an integral part of most aspects of motor skill performance. In fact, Gorman maintains that although the physical aspects of a skill are usually more readily observed - either the gross movements of the body or the manipulative movements of the hands - the knowledge of how to do and the image or strategy of what to do, may actually be more important. (1974, pp341-342)

In this booklet we shall be concerned primarily with those skills which are predominantly manual or motor in nature. These are often referred to simply as psychomotor skills. It must be remembered however, that these motor or psychomotor skills are complex patterns of activity usually involving all three behavioural elements: motor, perceptual and cognitive/language. It may well be found, also, that some of the psychological variables which influence skilled performance are more important for the manipulative or motor components of a skill whereas others may be more important for the perceptual or cognitive components.

Figure 1 - Categories of Skilled Performance



Adapted from Jones & Whittaker, 1975, p10.

Nature and Range of Psychomotor Skills Taught in TAFE

Psychomotor skills taught in TAFE generally are those fine manipulative or precision skills which underlie the practice of some vocation or the fine arts. They range from basic skilled operations such as filing a metal block straight and square, sharpening a hand scraper, threading a needle, drilling a piece of timber, etc to the more complex tasks or jobs requiring the integration of some of these basic operations. These include tasks such as constructing a vee pulley, building a cabinet, making a pastry, etc.

Gagne draws the distinction between basic motor skills and the larger units of action which he calls 'procedures' (1977, p211). He makes the point that many of the motor skills taught in TAFE occur as parts of more complex tasks or procedures and that the procedures are often built on intellectual and perceptual skills as well as the manual or motor components.

An example of this might be found in the construction of a round inclined branch in Boilermaking. This is a task which involves perceptual skills such as the estimation of line and angle, cognitive skills such as calculating mean diameters as well as the motor skills required in marking, cutting, assembling, etc.

It is worth restating therefore that while certain psychomotor skills may be seen as predominantly manual or motor in nature, most psychomotor skills taught in TAFE involve perceptual and cognitive elements as well. It is the relative importance or predominance of each element which tends to vary from skill to skill and this may in turn depend on the stage of skill acquisition or development which a learner has reached.

Stages in the Acquisition of a Skill

On the basis of laboratory observations and interviews with instructors, Fitts (1964, p65) proposed that the learning of a complex skill progresses through three stages which he identified as: an early cognitive stage, a lengthy practice or fixation stage and a final autonomous stage (reported in Kuhlen, 1968, pp390-404).

The Early-Cognitive Stage

During this stage, which is of relatively short duration, the learner attempts to understand the basic aspects of the skill and its demands. The skill may be demonstrated and explained and then the components analysed. Often the component parts of the skill are small operations in themselves and so the study of similarities and differences between the skill to be learned and other known skills can facilitate learning at this time. During this stage cognitive or intellectual elements would be emphasized.

The Practice-Fixation Stage

During this stage, which is relatively long, correct performance is gradually shaped and errors gradually eliminated. Once the succession of individual component operations has been identified so that the learner knows the content and nature of each one, continued practice with supervision will gradually eliminate error and shape correct performance.

Although the learner is mainly involved with practising the skill and the new motor elements the cognitive and perceptual elements remain important as he becomes aware of the finer points of the skill, and learns various ways to correct errors (eg. attending to wrong cues, sub-tasks out of sequence, inserting extraneous components, etc).

The time required to eliminate errors during the intermediate stages of most skilled learning is great enough so that it is usually spread over several days, rather than being accomplished in a single session.

Final-Autonomous Stage

During this stage, the pattern of activity becomes practically automatic so that the learner can perform the required actions without concentrating on them.

Characteristics of this stage are increased facility; speed and accuracy; proper timing; anticipation of most of the possible circumstances in which the skill would be used; knowledge of the finer points of the skill; also the capacity to perform the skill well even in the face of distractions or while attending to other matters.

At this stage, motor aspects would predominate.

It should be emphasized that these stages should not be seen as distinct or discrete divisions but more as indicators that reflect the types of behaviour which tend to predominate at certain points in the learning of a skill. The stages clearly overlap and "progression from one to the other is a continuous rather than a discontinuous process". (Fitts, in Kuhlen, 1968, p399)

In addition, the order is not inflexible for all learners. At times an action may be tried and practised before it is consciously analysed and an expert in a subject field does not face quite the same task as the beginner. For adult learners in fact, who might be expected to bring gains to the task from previous experience, the early stage may be quite a short stage.

Nevertheless, the stages are generally valid for most learners and some understanding of the nature of each stage and the related behaviours should be beneficial to teachers who have to plan teaching procedures which are appropriate for each stage and for each learner involved.

Variables Important for the Development of Psychomotor Skills

There are of course many variables which may influence the development of psychomotor skills - both general and specific. Of these, four variables which may be manipulated by the teacher demand special attention.

1. Practice

   It is generally accepted that practice is necessary for the development of psychomotor skills. Teachers must take steps to ensure that practice is effective and that methods and schedules of practice are appropriate.

2. Guidance

   Practice tends to be more effective if preceded by some form of guidance or direction as to the skill to be acquired and the goal to be attained.

3. Feedback

   Practice is also more effective if students are supervised carefully and receive regular monitoring and feedback on their performance.

4. Motivation

Finally, it is also generally agreed that skills will be learned more readily if students are motivated to learn. That is, if they want to learn and improve and they see a reason to learn and improve.

Note

Ways in which these variables may be manipulated by the teacher and incorporated into teaching procedures will be described in the next section. The ways in which they have been found to influence skilled performance, through experimental research in Educational Psychology, will be examined in the final (advanced) section of the booklet.

ACTIVITIES AND QUESTIONS FOR DISCUSSION

1. List and briefly describe two motor, two cognitive and two perceptual skills which are important for successful performance in your trade or occupation. (3 marks)

2. Select a task or complex job which you might have to teach and break it down into component operations or steps. For each operation or step, list the motor, perceptual and cognitive elements which are required for successful performance of that step or operation. (3 marks)

. Example
Job: Construction of a G Clamp

OPERATIONS	BEHAVIOURAL ELEMENTS
1. File the Face	a. Cognitive ..... b. Perceptual ..... c. Motor .....

II TEACHING PSYCHOMOTOR SKILLS IN TAFE

A Simplified Model for Teaching Psychomotor Skills

Psychomotor skills are generally taught in TAFE by means of a form of instruction referred to as practical instruction. Practical instruction generally takes place in a practical or realistic setting such as a workshop, laboratory, building site, kitchen, bowling green, etc., and employs practical tools, materials and equipment such as files, hammers, test tubes, stoves, levels, etc.

The objectives of practical instruction may be thought of as follows.

a) The development of practical or psychomotor skills to a satisfactory standard of performance.

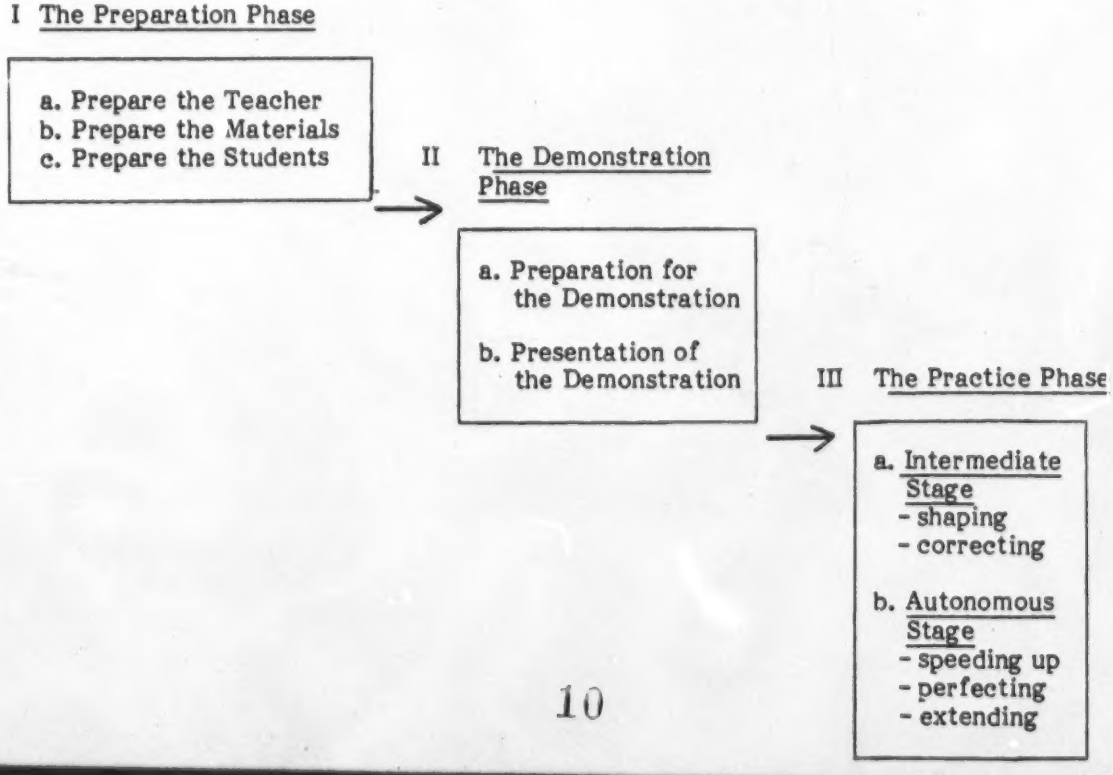
b) The strengthening of the pre-requisite knowledge and sensory and cognitive abilities necessary for the performance of those skills.

c) The fostering of those attitudes and habits of work necessary for the optimum performance of those skills.

These objectives are generally achieved by following three main phases of instruction. These may be thought of as: (1) the preparation phase; (2) the demonstration phase; (3) the practice phase. (The phases are presented diagrammatically in a simplified model for teaching psychomotor skills in Figure 2).

This model can be adapted to most types of psychomotor skill taught in TAFE and can be related to the three generally accepted stages in the acquisition of a skill which were previously described.

Figure 2 - A Simplified Model for Teaching Psychomotor Skills



1. The Preparation Phase

During the preparation phase of instruction the teacher generally prepares himself through analysis of the skill or task to be learned into component skills or operations, and by preparing the necessary tools, materials, equipment and teaching strategies for the teaching of those skills and operations.

At this time, also, the teacher will attempt to prepare his students through assessment of their readiness and by provision of an overview of the skill to be acquired or task to be completed.

During this phase, the learner will generally be at the early-cognitive stage of skill development attempting to achieve an initial understanding of the basic elements of the skill and its demands.

Language or cognitive elements of the skill such as conceptualization, identification and comprehension could be expected to predominate.

The most common teaching procedure is probably a combination of explanation, illustration and question-discussion and an important psychological variable is motivation. Motivation may be enhanced at this time by providing students with an acceptable reason to learn the skill and a worthwhile target or goal to aim at.

The teacher prepares himself and his materials.

2. The Demonstration Phase

The main purpose of the demonstration phase is to provide the students with guidance. That is, guidance as to the skill or task to be performed and the correct methods of performance.

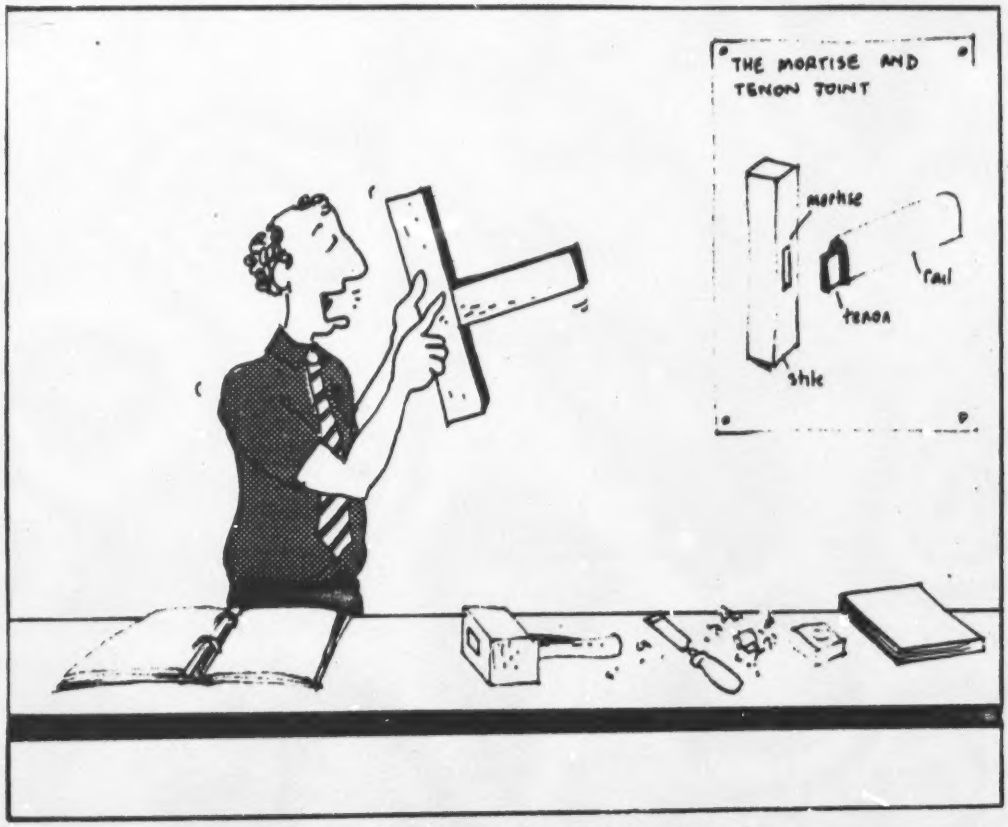
The most common teaching procedure employed to provide this guidance is undoubtedly the demonstration. That is, the demonstration by the teacher of the operations to be performed which constitute the skill or task together with his explanation of the correct techniques, materials and methods required for optimum performance.

It has been said that a good demonstration provides both "an overview of the skill to be acquired and a model to be imitated" (Klausmeier and Goodwin, 1966, p326).

In addition, it has been found that the demonstration is likely to be more effective if student involvement in and interpretation of the demonstration are maintained at a high level and if initial student responses are guided verbally as well as physically (Klausmeier and Ripple, 1971, pp506-509).

During the demonstration phase the student is likely still to be at the early-cognitive stage of skill development although acquiring a much clearer understanding of the component parts of the skill and of their relationship to one another and to the whole.

Perceptual and cognitive elements would now be important.



The teacher demonstrates and explains a procedure.

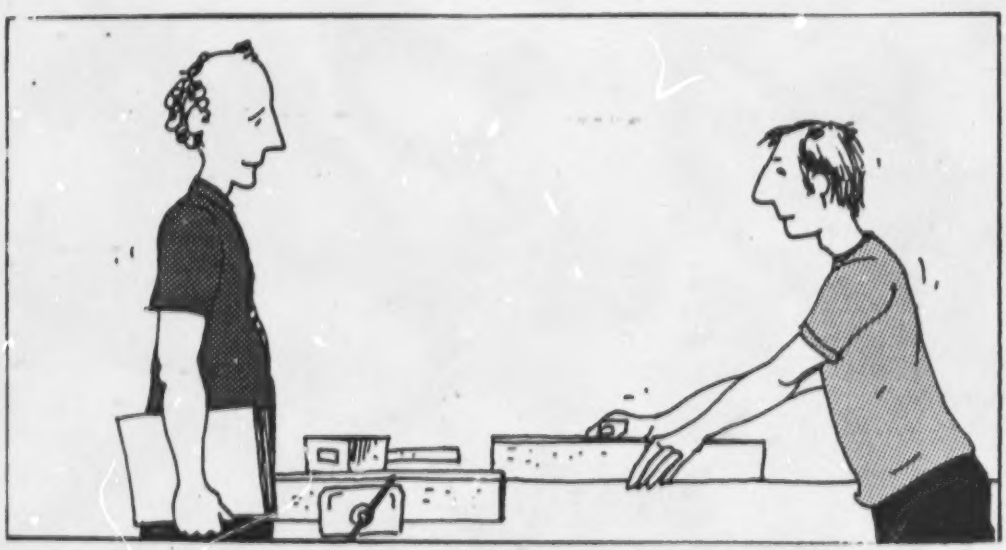
3. The Practice Phase

The practice phase tends to be the longest of the three phases and the objective of this phase is to gradually shape and perfect the students' performance or execution of the skill to be acquired.

During the early stages of the practice phase students would pass through the intermediate or fixation stage of skill development. The teaching emphasis would generally be on the gradual shaping of the correct performance of the skill and its component operations and on the elimination of errors. (Although in some circumstances speed might be stressed before accuracy). At this stage in the learning sequence motor elements would become more important.

During the later stages of the practice phase students hopefully would move into the final or autonomous stage of skill development. At this stage the emphasis would generally be on perfecting, speeding up, automatic performance and on extending the skill to more complex or realistic situations.

Throughout the practice phase of instruction the most important teaching variable clearly is practice. Teachers have the responsibility to ensure that practice is effective and that methods and schedules of practice employed are appropriate. In addition the teacher should let students know how well they are doing as often as possible by providing regular encouragement and feedback and he should take steps to maintain and enhance motivation for students to keep trying to do well.



The teacher provides supervision and feedback.

NOTE

The above description of the three phases of practical instruction is necessarily brief as the teaching procedures involved are probably well known already to most readers. (For a more detailed account of the teaching procedures employed in each phase, the reader is referred to the course: 'Theory and Practice of Teaching' and the reference booklets for that course entitled: 'Teaching in TAFE' and 'Practical Instruction in TAFE').

This booklet is concerned chiefly with the psychology of psychomotor skills. Its main purpose is to describe the psychological variables which have been found to influence the learning of psychomotor skills so that teachers may widen their knowledge on this matter and apply these variables in the practical classroom to improve their teaching of psychomotor skills through the various stages and phases.

This shall be attempted in Part B of this booklet.

ACTIVITIES AND QUESTIONS FOR DISCUSSION

3. Select a basic skill OR a complex task which you might have to teach (it may be one already described in Question 1).

   Briefly describe a set of activities or procedures which you would follow to teach this skill or task during the following four phases of instruction.

   a. The Preparation Phase.
   b. The Demonstration Phase.
   c. The Intermediate Practice Phase.
   d. The Autonomous Practice Phase. (4 marks)

4. Briefly comment on the relative importance of cognitive, motor and perceptual elements during each of these four phases. (2 marks)

PART B: ADVANCED

THE INFLUENCE OF CERTAIN VARIABLES ON THE LEARNING OF PSYCHOMOTOR SKILLS

I PRACTICE

Psychomotor skills are largely acquired and developed through practice. Of all the teaching tools available for the teaching of skills, practice or repetition or 'having a go' is most readily at hand and frequently used. Practice has been defined as "repetition of the procedure with intent on the part of the learner to achieve an improved performance" (Gagne, 1977, p 217). Skills as diverse as filing a block, reading a gauge, soldering a joint, pruning a plant etc. are all developed through practice in the college classroom, workshop, laboratory or site.

As Cronbach puts it, "skilled performance ..... is developed in the same general way as other learning, but it is a more polished and automatic form of response. It is attained through practice." (1961, p 355).

When a device such as practice is so readily at hand, however, and so thoroughly supported by tradition, there is a danger that teachers may tend to over use it and assume too much of it. Simple practice alone may not always lead to a desired rate of learning and teachers who rely heavily on practice to develop psychomotor skills should consider the following questions.

What are the common effects of practice?

Does practice always lead to a desirable rate of improvement?

Will the effects of practice show out from the beginning and be continued through all stages of learning?

Under what circumstances can the effects of practice be improved?

What other variables or teaching procedures can be introduced to improve the effectiveness of practice?

Researchers in Educational Psychology have attempted to provide answers to these questions.

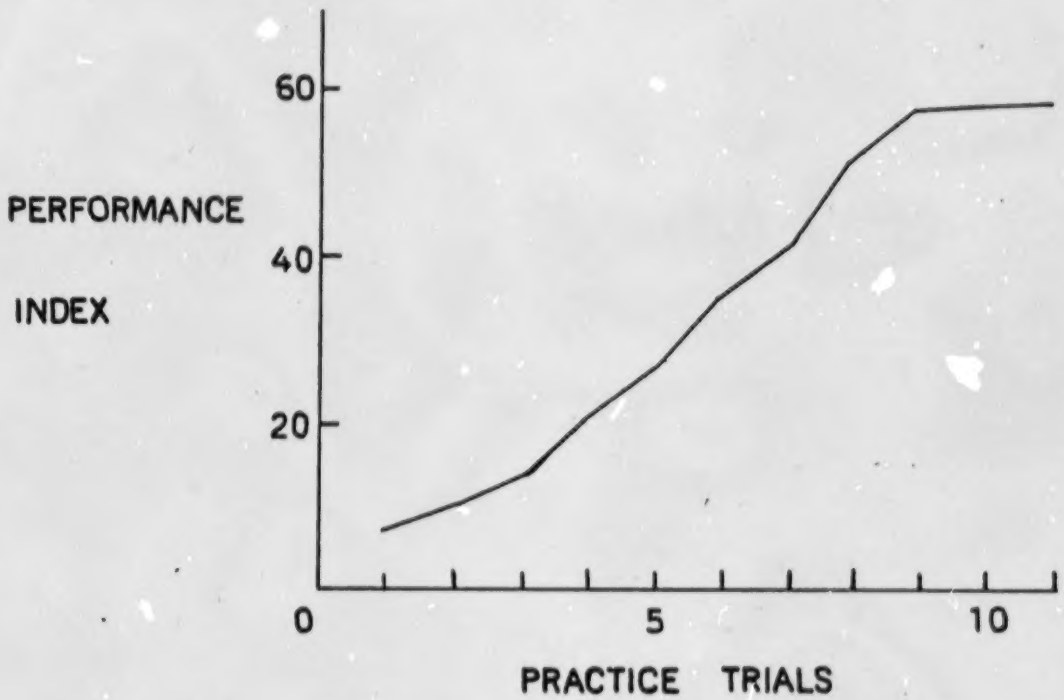
Measuring the Effects of Practice

An experiment to investigate the effects of practice typically contains the following steps.

1. Learners practise a skill, such as typing, (individually or in groups) over a number of trial or practice sessions; e.g. ten x 20 minute practice trials.
2. Measures are taken of performance on each trial; e.g. words per minute on each trial, decrease in errors on each trial.
3. The improvement from trial to trial is recorded graphically.

The result is referred to as a learning or performance curve.

Figure 3 - A Typical Learning or Performance Curve.



Results of experiments when presented in this way provide the following information.

(i) The amount of improvement due to practice; (difference between performance on trials 1 and 10).

(ii) The rate of improvement due to practice; (slope of curve - gradual or steep).

(iii) The pattern of improvement; (shape of curve).

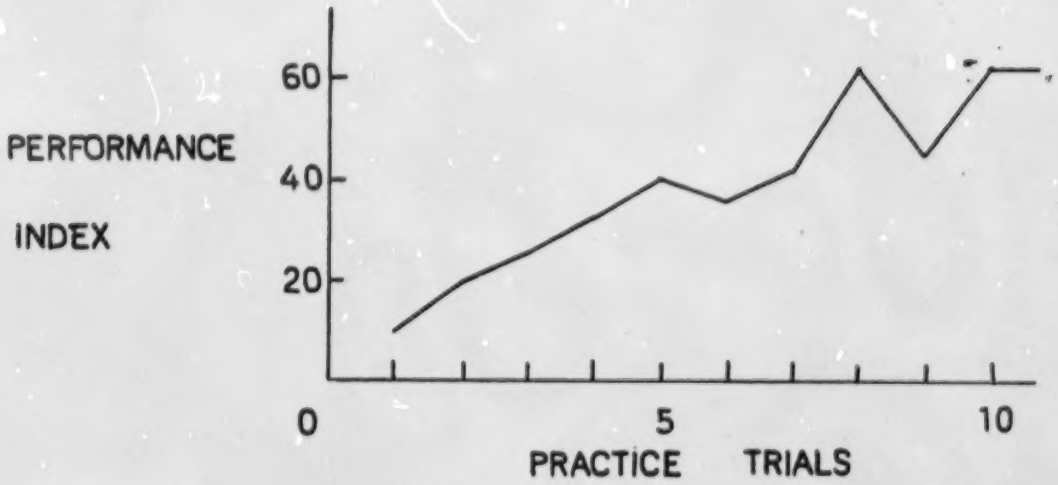
(NB: Of course most learning curves are ragged in nature, but they are often presented as smooth lines for ease of interpretation.)

Some Common Effects of Practice

Practice has been shown under different circumstances to have various effects on the learning and performance of psychomotor skills. These effects moreover may show out at different stages in the learning or practice sequence.

a. Decreasing Returns for Practice
(or negative acceleration)

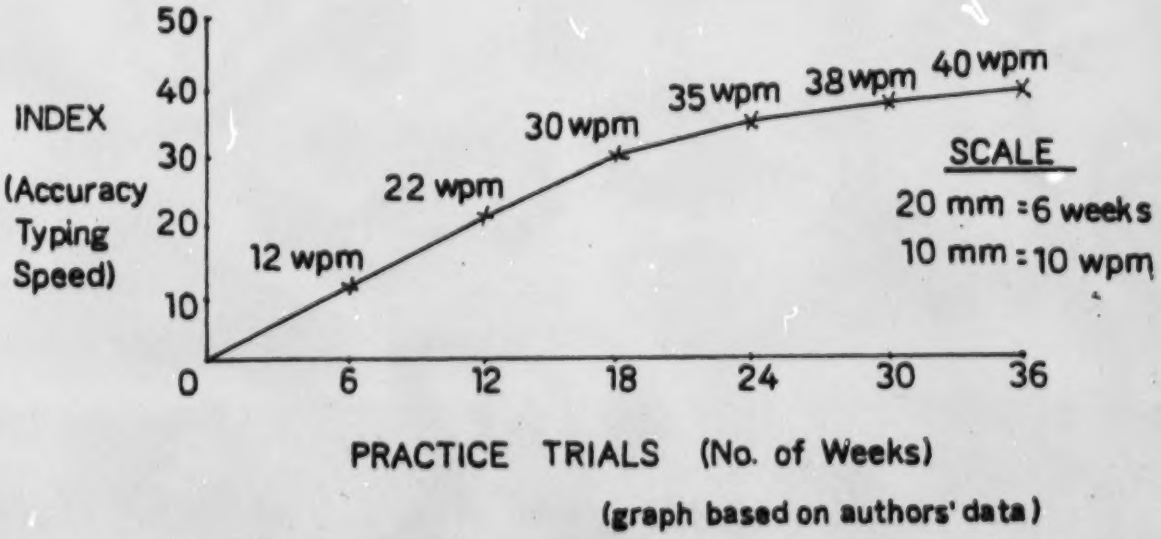
Figure 4 - Graph Showing Decreasing Returns for Practice.



This pattern of performance is typified by a rapid rate of improvement during the early practice periods or trials followed by a slowing down or deceleration in the rate over the later trials. Although practice continues at the same rate, the returns from practice tend to decrease or decline.

This pattern or change in returns for practice is illustrated by the following record of a student's progress in learning to type.

Figure 5 - Graph Showing Change in Accuracy Typing Speed with Successive Periods of Practice



(graph based on authors' data)

The reason for a rapid improvement early is often that the learner brings to the task some prior knowledge and experience which are helpful or that initial aspects of the skill are relatively easy and interesting (both of these circumstances usually apply in learning to type).

The levelling off or slowing down in the rate of improvement after a good start is a common occurrence and presents a genuine problem. This may be brought about by increasing levels of difficulty, higher standards being required or because the learner is reaching some limits to performance. The learner may be reaching his or her physical limits or the limits of a particular machine or piece of equipment.

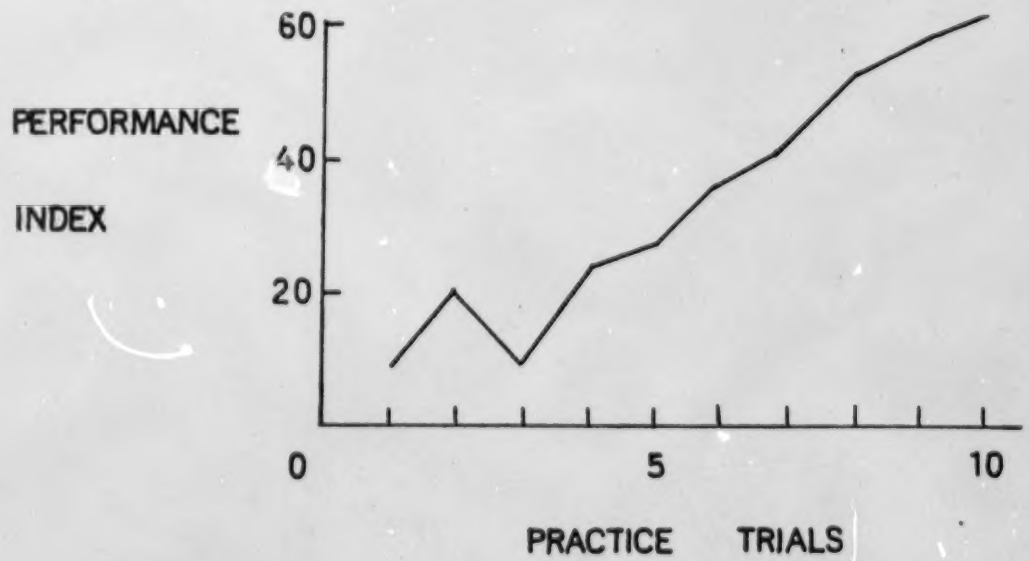
More commonly, though, it has been found that learners reach psychological limits. That is, they reach a stage of efficiency which is acceptable to themselves and stop trying to improve. Sometimes improvement may cease altogether resulting in a phenomenon known as a learning plateau which is discussed later. The concept of limits is well illustrated in De Cecco & Crawford (1974, p 254).

Most teachers find it easy to bring about some initial improvement during the early stages of learning a skill. Maintaining a satisfactory rate of improvement as practice continues, though, and restoring improvement following plateaus and declines represents a much more challenging task.

b. Increasing Returns for Practice

(or positive acceleration)

Figure 6 - Graph Showing Increasing Returns for Practice.



This pattern of performance is typified by a slow rate of improvement during the early practice trials followed by a rapidly increasing or accelerating rate over the later trials. That is, the progress at the start is slow, but as practice continues, returns increase and the learning rate improves.

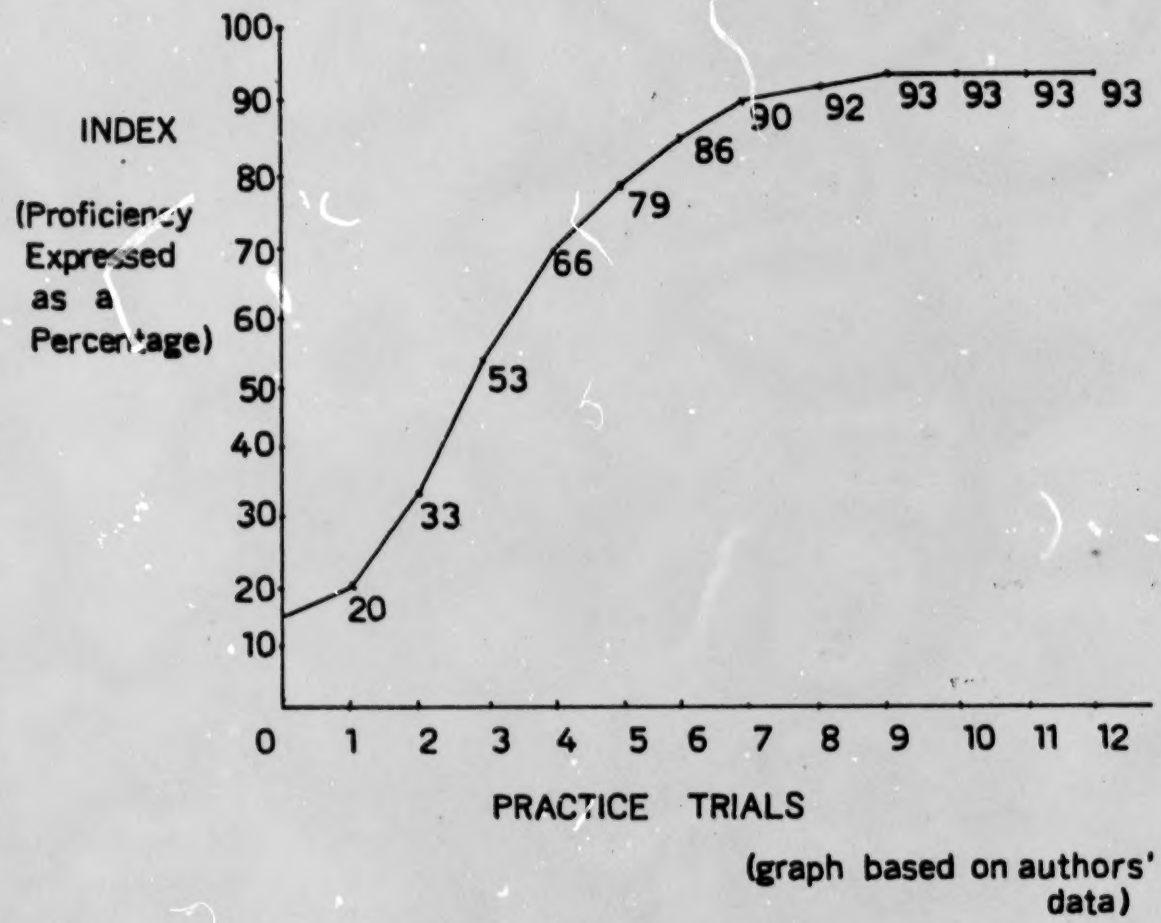
This pattern may occur when the task is completely new or novel. It has been reported in experiments involving novel skills such as mirror tracing and in the intitial stages of learning a new language.

The story of Helen Keller's learning of language represents an interesting account of increasing returns. Early attempts to learn the basic words were frustrating and many hours of practice resulted in the mastery of few words. Gradually, though, as more words were mastered these aided in the learning of new words. The result was a snowballing effect in which each practice trial made the next trial more effective. (Reported in Stephens, 1956, p 317).

The lack of progress during the early practice trials may also be caused, however, by failure of the teacher to provide a clear concept of the task or skill at the outset or failure to detect a fundamental error in the learner's technique.

These two common effects of practice have been separated here for purposes of explanation. It is important to realise, however, that these and other common outcomes may occur together during the course of learning a single skill. This is illustrated in the following graph showing rate of improvement in learning to make a dovetailed joint.

Figure 7 - Graph Showing Rate of Improvement in Making A Dovetailed Joint in Timber Using a Handsaw and Chisel; with Successive Periods of Practice.



This record of performance shows periods of increasing returns (trials 1 to 3), equal returns (trials 3 to 5), decreasing returns (trials 5 to 7) and a learning plateau.

c. The Learning Plateau

A learning plateau can be thought of as a period of practice or series of practice sessions with no corresponding improvement in skilled performance. That is, a zero rate of improvement. This can be observed on the previous graph from trials 8 to 12. Here, although practice continues, no further improvement in performance is apparent.

When a plateau occurs at a relatively high standard of performance (as in this case) it may be expected and should give no great cause for concern. Often they occur, however, when the standard of performance attained is far from satisfactory even at a very early stage of learning. Plateaus of this kind represent a common and serious problem for teachers concerned with the development of psychomotor skills and some consideration of their causes may at this point be useful.

Plateaus in learning may be associated with any of the following factors:

- Lack of maturity in the learner;
- Use of an inefficient method or schedule of practice;
- Failure to master an important step or operation;
- Concentration by the learner on only one aspect of a complex task;
- Reaching limits of performance;
- Repetition of an error in technique;
- Poor concept of the task;
- Boredom and fatigue.

(These are described fully in most basic references on the topic).

Further consideration of these factors and the circumstances under which they may lead to plateaus in learning should point the way to the procedures which teachers should adopt to prevent or overcome them.

NOW COMPLETE CLASS EXERCISE 1 "The Effects of Practice on the Performance of a Simple Skill"

(see Appendix)

And prepare answers to the Questions for Discussion.

Note

You should consider the factors which contributed to your pattern of performance during practice and ways in which the effectiveness of the practice could have been improved.

This will lead you to a consideration of the variables which are discussed next in this booklet.

II GUIDANCE

What is Meant by Guidance?

One fairly obvious way in which the effectiveness of practice can be improved is to provide some guidance for learners before practice begins.

Guidance has been defined as any arrangement or set of circumstances (usually brought about by the teacher) "whereby a learner is led, or directed, or forced into correct behaviour." (Stephens, 1956, p 335). Guidance is usually designed to provide learners with some conception of the correct response before performance begins and to thereby eliminate the errors and floundering around which characterise most trial-and-error learning or unguided practice.

Holding distinguishes four major types of guidance.

a. Physical restrictions where guidance is provided by physical restraints (harnesses, belts, etc.) which 'block off' incorrect responses.

b. Forced responses where guidance is provided by physically controlling or forcing the correct responses.

c. Visual guidance where guidance is provided by visual cues and materials such as models, charts etc.

d. Verbal guidance where guidance is provided by means of verbal instructions.

(Holding, 1970, p 266)

These forms of physical, visual and verbal guidance are all directed at the elimination of errors when students practise and they may all come together in a typical teacher's demonstration.

The Demonstration as Guidance

Perhaps the most common way of providing guidance when teaching a psychomotor skill is to provide a demonstration of that skill before practice begins. Most teachers and educational psychologists agree that, whichever method or schedule of practice is being used, a clear demonstration of the skill to be acquired together with an overview of the task or goal to be attained will generally assist students in the performance of that skill and the attainment of that goal.

As Cronbach puts it, "Skills can be developed by unaided trial and error, but ordinarily it is better to assist the learner by showing him the correct response." (1961, p 370).

According to Lovell, a demonstration is one of the major ways that the instructor conveys to the novice information about the kind of performance he is working towards and is expected to achieve. In addition, the demonstration is often used "to point up for the novice which informational cues he must attend to". (1980, p 82).

Although there is much agreement on the value of the demonstration as a form of guidance, the following questions arise which are of interest to teachers.

What are the common effects of a demonstration, on the learning of a psychomotor skill? and

What can teachers do to improve the effectiveness of their demonstrations?

Educational Psychology provides us with some answers to these questions also.

Some Common Effects of Demonstrations

1. Most of the available evidence suggests that practice is generally more efficient if preceded by a demonstration.

An experiment reported in Cronbach (1961) and Klausmeier and Ripple (1971), in which two groups of women were taught the skill of archery is typical of experiments which have investigated this issue. In this experiment, one group referred to as the tuition group was given a demonstration and verbal instructions on how to stand, how to hold the bow, how to release the arrow etc. The women in the control group were given only the necessary equipment, minimum safety instructions and then proceeded on their own. Both groups had eighteen practice sessions over a three month period.

Cronbach reports that after the eighteen practice sessions the tuition group was hitting the target on 65% of its shots compared to 45% for the group with practice only. (1961, p 370) Moreover the tuition group tended to concentrate on correct form and technique whereas the control group members acquired inefficient techniques which tended to persist throughout the experiment.

It was concluded that a demonstration aids the learning of skills in at least three ways.

a. The learner is directed to adequate technique.

b. Insight is promoted concerning factors related to success.

c. The learner is given a feeling of security and confidence.

(Klausmeier & Ripple, 1971, p 507)

2. A Demonstration is generally more effective if learners give it their full attention and try to interpret what the demonstrator is doing.

A clever experiment reported in Cronbach (1961, pp 371-372) provides teachers with some interesting ideas on ways to improve the effectiveness of their demonstrations. In this experiment, the subjects were given a demonstration on how to do a complex jigsaw puzzle, after which they were required to practise the puzzle until they could do it without error. During the demonstration, however, the subjects were required to do different things. Some were instructed to count aloud by two's. Others were told to keep silent while others were told to describe or interpret what the demonstrator was doing. This latter condition of course requires the learner to pay attention and be mentally active and is analogous to a teacher continually asking 'what', 'how' and 'why' questions during a demonstration.

The results indicated that the subjects who were called on to interpret the demonstration and who received feedback on their errors were the best performers when called on to practise the complex puzzle. Subjects who remained silent and received a full description also performed well.

This study provides good evidence of the importance of concentration and active interpretation on the part of learners in improving the effectiveness of a demonstration.

3. Guide responses verbally as well as physically

There is ample evidence that physical as well as verbal guidance can be used to improve the effectiveness of demonstrations.

Klausmeier and Goodwin report that verbal instructions on such matters as correct technique, strategies or methods of attack, and on factors related to task proficiency, have been found to improve performance on skills as widely ranging as flying an aircraft, ten pin bowling and speech correction. (1966, pp 327-329).

These findings underline the need, when preparing for a demonstration to prepare what to say as well as what to do although Gorman warns that these verbal instructions in the early stages need to be brief and simple. Verbal explanations which are too extensive or too complicated, he maintains, can be quite ineffective (1974, pp 353-354).

Klausmeier and Goodwin also provide a good example of the effectiveness of physical guidance in such a skill as speech correction where leaners are instructed to hold a toothpick or straw in such a way as to establish or 'force' the correct position of the tongue and teeth for various sounds. (1966, p 329).

Holding reviews a number of studies which examine the effectiveness of physical guidance on the performance of a variety of psychomotor skills. The studies investigated the effects of restriction methods where errors and incorrect technique are physically blocked off and forced response methods where the correct physical movement of the limbs is controlled and forced. Both methods were found to be effective under different circumstances in eliminating early errors and in improving the efficiency of skilled performance. (1970, pp 267-274).

4. Demonstrations may be more effective when visual aids are used.

Although a demonstration is itself a form of visual guidance, such guidance can be enhanced by the provision of visual aids such as charts, drawings, transparencies, models, motion pictures, loop films and video tapes.

Cronbach reports that in one experiment on learning lathe operation, learners who saw a demonstration on film learned faster than those who had a conventional demonstration. Similarly, films were found to be effective in learning the 'western roll' style of high jumping. (1961, p 371).

The effectiveness of visual aids in demonstrations comes about from the fact that they provide additional, alternative, expanded and often clearer views of the skill or task. They bring added authority to the classroom and they can be repeated over and over again. They may be left in view or on show while practice continues and the video tape provides the extra bonus that students can see themselves perform and detect their own errors. Video tapes and films are now used extensively in the coaching of sporting skills. There is no good reason why they should not be similarly used in the TAFE classroom and workshop for vocational skills.

Finally, a few general comments by Gorman provide a useful conclusion to this section. To ensure an effective demonstration, says Gorman, provide a brief demonstration and explanation of the skill as a whole, in the early stages emphasising those aspects essential and important at the beginning. Avoid the dangers of over-long demonstrations, too much verbalisation and too much attention to detail and don't be afraid to allow some student discovery through trial and error in the early stages. In short, "a minimum of verbal explanation and a maximum of student involvement is the most effective approach." (1974, pp353-357).

ACTIVITIES AND QUESTIONS FOR DISCUSSION

5. Describe <u>two</u> procedures which have been used or could be used to improve the effectiveness of demonstrations in your TAFE school or college. (2 marks)

6. Describe an experiment which has investigated the effects of some form of guidance on the learning of psychomotor skills. Explain the implications of the experiment for the teaching of psychomotor skills in TAFE. (Acknowledge all references used). (2 marks)

III FEEDBACK

What is Meant by Feedback?

Another way in which the effectiveness of practice can be improved is to provide feedback to learners during and following practice. As Cronbach explains, "Learning of any performance contains two stages, although they develop together and cannot be sharply divided. A person must first have a general conception of the response. Second, having grasped this general guiding pattern, he refines it." (1961, p 360). During the first stage the learner requires guidance, that is guidance as to the general requirements of the task and the cues which direct action - this was discussed in the previous section of the booklet. During the second stage of learning, however, the learner is required to gradually develop or shape skilled performance - that is gradually make finer and more rapid discriminations and more co-ordinated actions. No amount of guidance on its own will develop this type of skilled performance. For skill learning to take place the learner also requires "information or feedback about the consequences of his actions." (Lovell, 1980, p 82).

Feedback can be thought of as "the perceptual information that follows as a consequence of the actions taken by a person carrying out a skill." (Lovell, 1980, p 82). A skilled action we have seen is not a smooth fixed action. It is more a complex combination of split-second tries and adjustments. Feedback can be thought of as information conveyed to the learner via his senses to allow him to constantly adjust his responses to more closely approach some target or standard set of responses. Skilled performance is constantly being regulated by feedback of information conveying the consequences of his actions to the learner.

Feedback or Reinforcement

Feedback is often confused with the psychological concept of reinforcement. Both refer to the consequences which follow an action and both provide useful information to the learner.

Reinforcement, however, tends to emphasize the hedonistic or reward aspects of feedback. A correct response leads to a reward (positive reinforcement). An incorrect response leads to no reward (negative reinforcement). The rat presses the correct bar and receives a food pellet, the patient walks downstairs and receives candy. In this way reinforcement has been a powerful tool in most animal training, much clinical rehabilitation and certain forms of human social learning.

Feedback, on the other hand, emphasises the informational aspects of learning. It is in a sense a wider concept than reinforcement. Feedback may provide the learner not only with qualitative information about whether his response was correct or incorrect, good or bad, but also with quantitative information about why it was correct or incorrect. In addition, corrective or remedial information about what measures are required to correct a response if correction is necessary may also be provided. For this reason, De Cecco & Crawford see feedback as a more useful concept than reinforcement when applied to skill learning and define it as "the information available to the student which makes possible the comparison of his actual performance with some standard performance of a skill." (1974, p 260).

Modes or Sources of Feedback

Most authors distinguish between two modes or sources of feedback: internal and external. (De Cecco & Crawford, 1974, p 200; Lovell, 1980, p 82).

Information generated by the internal receptor organs, notably the kinaesthetic sense residing in muscles, joints and tendons, is referred to as internal feedback. This type of feedback provides us with information about the movement and positioning of our body and limbs while the skilled action is occuring. The skilled darts player feels the incorrect position of the throwing arm before releasing the dart. The expert typist will feel the incorrect finger action and make a split-second adjustment before hitting the key. The skilled welder will feel the incorrect position of the rod and intuitively adjust the angle. The use of this type of feedback is a feature of the skilled or accomplished performer and should be used more and more by the learner as he moves from the fixation to the autonomous stage of skill learning.

Before the learner gets to this stage, however, he will rely more on external feedback. External feedback is generated by the external sensory organs - sight, hearing, touch, taste or smell, and comes more from the consequences of the action rather than the action itself. "The action taken," says Lovell, "creates the external feedback." (1980, p 82). The darts player sees the consequences of his action in a score on the board. The typist checks her copy for errors. The welder visually checks the angle or inspects the weld. The cook tastes the sauce, etc.

This latter type of feedback is a feature of the fixation stage of skill learning. It is often referred to as knowledge of results and is a matter of chief concern and responsibility for the teacher.

Knowledge of Results

Knowledge of results can be thought of as feedback information provided to a learner about the consequences or correctness of a given action or response. It is generally agreed that this type of feedback, like guidance, is an essential ingredient in the acquisition of skilled performance. Knowledge of results allows the learner to compare his performance with some external standard or model and thereby, along with guidance, represents a chief tool in the gradual elimination of error and gradual shaping of the desired performance.

Feedback stemming from knowledge of results may be of two main types: intrinsic and extrinsic or augmented. (De Cecco & Crawford, 1974, p 260; Holding, 1970, p 249).

Intrinsic feedback here refers to knowledge of results stemming from the task itself or the consequences of the learner's own actions - the result of the shot, the appearance of the weld, the correctness of the copy etc. Extrinsic or augmented feedback refers to knowledge of results provided by some source external to the learner and his task. This type of feedback is usually provided by the teacher and it is often augmented or added to for training purposes though such devices as marks, grades, comments, rewards, models, visual aids, etc.

Holding points out also that knowledge of results may be provided while the task is being performed (concurrent) or on its completion (terminal); immediately on completion of the response (immediate) or some time later (delayed); and by verbal or non verbal means. (1970, pp 249-250).

The important point to be learned by teachers, though, about this type of feedback, is that eventually the learner must be brought to the point where he can rely on the intrinsic feedback from the task and his own actions rather than the augmented feedback provided by the teacher. As Holding puts it, "there is no point in learning to rely upon information which will not be there when training is finished." (1970, p 250).

The onus is very much on the teacher, therefore, to seek out ways of providing knowledge of results which not only serve to eliminate errors and shape desired responses but which also assist the learner to progress through the fixation or intermediate and into the autonomous stage of skill learning. That is to gradually relinquish external and extrinsic sources of feedback and to rely more and more on intrinsic and internal cues.

Evidence from Educational Psychology may be a source of inspiration here also.

Some Common Effects of Knowledge of Results

1. It is generally agreed that practice accompanied by knowledge of results is more effective than practice without knowledge of results - in the development of skilled performance.

This simple principle has been well established and well demonstrated in experiment after experiment. It has been succinctly stated as follows:

> Knowledge of results is one of the most powerful variables in skill learning. There is no improvement without knowledge of results; there is progressive improvement with such knowledge; there is deterioration after its withdrawal.
>
> (Klausmeier & Ripple, 1971, p 513)

An early experiment by Thorndike is typical of experiments which have demonstrated these effects. Thorndike had two groups drawing pencil lines of specified lengths for several days while they were blindfolded. The group which was given verbal knowledge of results by the experimenter showed good improvement whereas the group given no knowledge of results showed no improvement although they continued to practise. (Reported in Lovell, 1980, p 83).

Since that time, knowledge of results has been shown to be advantageous in the performance of various laboratory tasks such as directing a spot of light on the bull's-eye of a target and reproducing the length of a piece of wood while blindfolded. It has been found to be effective moreover in more realistic tasks such as learning chemistry and in assisting soldiers to improve their marksmanship. (See Munn 1961, pp 435-437; Morgan and King, 1966, pp 124-126). Furthermore, knowledge of results seems to have a general motivational effect in addition to its direct effect on learning. Various authors have mentioned that when knowledge of results is not provided or withdrawn, learners tend to become bored and lose their keenness.

In commenting on these findings, Munn has suggested that the improved performance associated with the provision of knowledge of results is probably due to three factors.

> a. Repetition of responses known to be successful.
> b. Attempts to correct responses known to be inadequate.
> c. Enhanced motivation.
>
> (1961, p 437)

The implications of these findings for teaching are obvious and are concisely stated by Klausmeier and Goodwin. It is clear, say these authors, that when teaching students to acquire skills, "the teacher - should provide arrangements so that knowledge of results is readily available. This principle has been thoroughly established for a long time." (1966, p 335).

What is not so well established, however, is the way in which this knowledge of results might be provided in a crowded classroom. The teacher is not like a machine or even like an experimenter conducting a controlled experiment. When called on to teach practical skills to a class of fifteen or twenty students of varied ability he may be very hard pressed to provide knowledge of results to every student for every response throughout the duration of the learning task.

While the general effects of knowledge of results are well established and well accepted, therefore, the teacher may be more interested in other related questions. The teacher may want to know, for instance, whether it is necessary to provide knowledge of results throughout the duration of the learning, and on every trial and immediately after each trial. He may also want to know which are the most suitable types of knowledge of results and feedback strategy for different types of skill.

There are some interesting and encouraging findings on these issues also.

2. Regular knowledge of results is most important in the early stages of skill learning but may be withdrawn in the later stages.

In the experiment referred to above by Baker and Young (1960), the group which had received knowledge of results from the beginning, had this feedback withdrawn after seven days of practice. Although their standard of performance dropped, they continued to perform at a higher standard than the group which received no feedback from the beginning and which did not improve at all. This effect has been observed in other studies (see Braverman & De Caro, 1979, p 12) and the implication for hardpressed teachers is encouraging. It would appear that if teachers can provide regular knowledge of results during the early stages of learning a skill they may gradually withdraw or reduce it, without too much danger, as learners become more proficient. This is a doubly useful finding as the withdrawal of teacher or extrinsic feedback would also encourage the learner to take more notice of the intrinsic cues - that is to become more self-proficient.

This finding can be linked with an interesting finding reported by Mednick that subjects who received only intermittent rewards (partial reinforcement) when playing slot machines continued to play much longer than those who received rewards on every trial. (1974, p 47). According to Mednick, this finding has similar implications for training to those outlined above. That is, in the early stages of training the teacher should provide feedback liberally. As the learner develops skill, however, this should taper off. By tapering off the extrinsic feedback, we not only encourage the learner to attend to other cues, but also "assure the response a long life even when we are not nearby to apply frequent reinforcements." (Mednick, 1964, p 47).

3. Immediate knowledge of results is generally more effective than delayed but small delay may not be too harmful.

Early experiments on this question indicated that immediate knowledge of results was more effective than delayed and that increases in the delay before feedback was given tended to reduce the rate of learning (see De Cecco and Crawford, 1974, pp 261-262). A more recent review of studies into this question by Holding (1970) indicates however that the findings are not as clear cut as was first thought. This

author observes that for a series of studies involving simple motor tasks such as ball throwing, lever pressing, etc, the effects of delay can vary depending on the nature of the task, the nature of the feedback and the time of delay, saying that in some cases "we may even expect delay to be beneficial." (1970, pp 255-258).

This also is an encouraging finding for teachers hardpressed to provide knowledge of results immediately following all key responses for all students. As Holding points out, the effects of delay are not too serious as long as the knowledge of results provided is unambiguously seen to belong to the response in question and there are not too many intervening responses between the key response and the knowledge of results. (1970, p 257).

The delay in fact may prove to be beneficial as it may force the learner to look for intrinsic cues while waiting for extrinsic feedback from the teacher. This may in turn improve retention of the skill as we often forget that "retaining the skill will depend upon the intrinsic cues when extra feedback is removed." (Holding, 1970, p 257).

4. Knowledge of results should be appropriate for the skills being learned.

Braverman and De Caro (1979) reviewed a number of studies which looked at the effects of different types of knowledge of results and feedback strategy on what were called 'closed loop or simple motor skills'. Closed loop skills are those such as applying a bolt with an air wrench which can be broken down into sub-skills or operations (closed loops) such as loading the wrench, applying the socket etc. These skills, point out the authors, require heavily guided learning and error correction of a simple kind and are similar to a host of machine and workshop skills taught in technical and vocational education.

Braverman and De Caro report that in a number of studies, a simple type of right/wrong or correct/incorrect feedback was found to be effective in improving performance on these simple closed loop skills (1979, p 10). They found that, for these skills also, a delay in knowledge of results had little effect, withdrawal of knowledge of results in the early stages of learning resulted in deterioration of performance, and that after a relatively large amount of training, learning could continue when knowledge of results was withdrawn. In addition, feedback through more than one sensory channel (e.g. visual and verbal) tended to be more effective than one channel alone. (1979, pp 10-12).

These authors also reviewed a number of studies which examined the effects of videotaped feedback on what were called 'complex open loop motor skills' (1979, p 12). Open loop skills are those such as hitting a baseball where the movements required are so rapid and integrated that there is no opportunity for feedback or error regulation until the termination of the task. For these skills, moreover, the response demands placed on the learner are often unpredictable so that feedback information needs to be more complex and complete than that provided with simple closed loop operations. Videotaped playback of the complete performance of a skill or task on completion is capable of providing this more extensive type of feedback.

Braverman and De Caro report that videotaped feedback proved more effective than traditional feedback in enhancing performance on certain open loop skills required by karate, swimming, golf and badminton (1979, pp 12-14).

There are implications here for those teachers required to teach complex, integrated skills which can not easily be broken down into component operations and for those who prefer to delay feedback until completion of the full task rather than provide it on completion of each component operation.

In summarising their findings on knowledge of results, Braverman and De Caro make a number of positive suggestions for the teaching of machine and workshop skills which they suggest can be applied equally to the typical apprenticeship class situation or to the development of more individualised instructional models. These are offered here as a fitting conclusion to this section.

1. Analysis of the skill should be made prior to instruction. Classification of the skill in terms of its open or closed loop characteristics should be performed.

2. Precise feedback is appropriate during the early stages of skill acquisition.

3. Frequent feedback is useful for closed loop skills during early stages of skill acquisition.

4. Withdrawal of feedback produces deterioration of performance at early stages of closed loop skill development. However, withdrawal of feedback is appropriate after a large amount of training has occurred.

5. There are a variety of feedback strategies available for a given motor skill. Kinesthetic feedback, visual feedback and verbal feedback have been found useful in a variety of situations.

   a) Verbal feedback appears to be useful for some types of fine motor closed loop skill acquisition.

   b) Visual feedback appears to be useful for some types of open loop skill acquisition.

   c) A combination of feedback types (visual and verbal, kinesthetic and verbal) appears more effective than any one feedback type used alone.

6. A systematic approach to teaching psychomotor skills can increase effectiveness of the teacher and facilitate student learning.

(1979, p 15)

NOW COMPLETE CLASS EXERCISE 2 "The Effects of Knowledge of Results on the Performance of a Simple Skill"

(See Appendix)

And prepare answers to the Questions for Discussion.

IV METHODS OF ORGANIZING PRACTICE
(or Schedules of Practice)

One of the questions arising from the discussion of feedback concerned the timing of feedback or the stage at which it should be provided. It was suggested that for certain complex or integrated skills, feedback should be provided on completion of the whole skill whereas for other simple skills, feedback might be provided regularly on completion of each component part or operation. It was also suggested that analysis of any skill or task should be completed before instruction is begun.

This raises a number of issues concerning the most appropriate methods of organizing practice. One of these is the question of part - whole arrangements for practice and the other is whether it is better to use massed or spaced practice.

Part-Whole Arrangements

It is generally suggested that for tightly integrated skills, where the difficulty level of each step or component is relatively uniform throughout, the so called whole method of instruction should be employed. That is, students receive a demonstration of the skill as a whole, then practise all aspects together. An example of such a skill would be the swan dive. For skills which are loosely organised, however, where the component parts are really logically self-contained skills and the difficulty level of each is different, then the so called part method is usually recommended. That is, students practise on each component skill first, then integrate them as soon as possible. An example of such a skill would be the game of baseball. (Gorman, 1974, p354; Morse and Wingo, 1969, p237).

Klausmeier & Ripple report on three studies in which the whole method proved superior to the part method. These studies involved the skills of juggling, rifle firing and learning to receive morse code (1971, p509). In the experiment involving the morse code, the whole method, whereby all 36 symbols were introduced in the first practice session proved to be more efficient than earlier part methods which involved lengthy practice on separate symbols (in Klausmeier & Ripple, 1971, p509).

It is often suggested also that the whole method is superior for intelligent and mature learners who can delay gratification and endure the frustration and lack of early rewards which are often associated with whole learning. Less mature learners, it is claimed, require the early rewards and tangible experience of success usually associated with part learning.

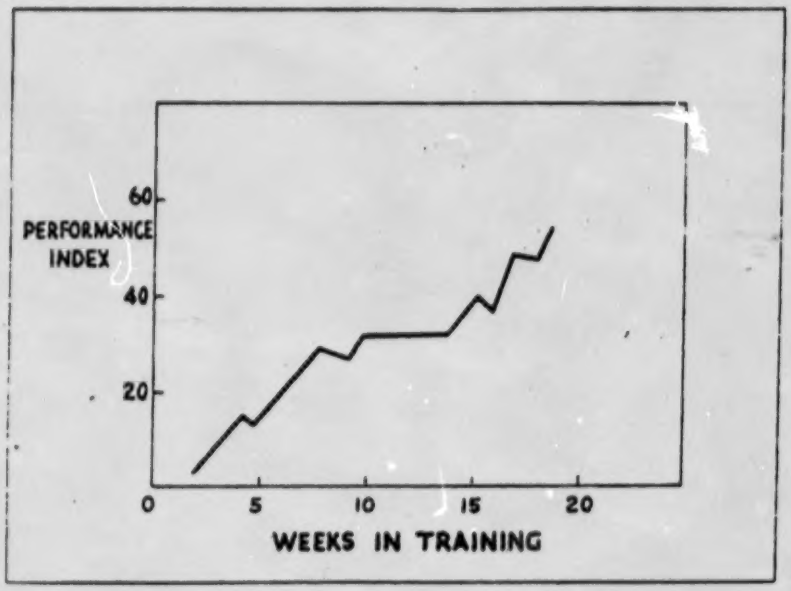
Unfortunately, many of the experiments on which these generalisations are based are confused and confusing. Any teacher who attempts to use them to produce an optimum schedule of practice "will be faced with a bewildering complexity of interrelated variables". (Ausubel & Robinson, 1969, p279). The most suitable method of practice seems to depend on the nature of the skill or task to be learned as well as variables such as the age, intelligence, maturity of the learners, etc. Moreover, many of the experiments have involved gross motor skills such as swimming, diving, juggling, playing baseball, etc highly unrelated to the finer more manipulative skills required by TAFE.

It is the opinion of this author that for most learners called on to learn the manipulative reasonably complex skills required by TAFE, time can be profitably spent practising and increasing precision and performance on the component skills and operations.

This impression is confirmed by a series of initiatives involving an interesting approach to training for complex skills in industry reported by O'Hara (1962).

According to O'Hara, much of the training in industry has been expensive and non-productive because it has called on learners to observe, then tackle relatively complex whole jobs on complicated and relatively fast moving machinery. This has resulted in learners exhibiting fears, anxieties, errors and learning pleateaus. (See Figure 8)

Figure 8 - Learning plateau caused by practice on an Inefficient Method



(from O'Hara, 1962, p6)

Learning of complex skills, says O'Hara, should be based on part rather than whole learning. Furthermore, instructions should move beyond the simple job breakdown with its concept of stages and keypoints to a 'deeper analysis' of each of these stages or operations into sensory and perceptual elements.

O'Hara then goes on to report on an approach used in industry in some quarters based on this so called Deep Analysis Method.

This approach to training incorporates three features.

1. First, the job or task is broken down into the conventional motor operations.

2. Each motor operation is then analysed and studied so to record the associated sensory - perceptual elements which require a high degree of control.

3. Then, special exercises and devices are designed to develop the required behaviours and the training program is based on these.

Examples of these specialised training methods were:

- exercises to strengthen wrist muscles for riveters;
- eye-exercises for operatives learning to make watch cases;
- exercises to improve eye-hand co-ordination for power sewing machine operators;
- a 'dartboard' device for the development of eye and hand co-ordination and accurate movement for workers in the Australian textile industry.

(1962, pp7-10)

O'Hara reports that the experimental evidence so far gained indicates that the deep analysis approach can effect a marked reduction in the time taken to train operatives on complex tasks (1962, p15).

In addition, the method has been used successfully in a wide range of industries such as mechanical and electrical engineering, telecommunications, pottery, hosiery, weaving, spinning, etc. and on operations which involve:

a. simple handwork;
b. handwork with tools;
c. single-purpose machine work;
d. multi-purpose machine work. (1962, p16)

Moreover, the technique and the principles involved are basic, says O'Hara, to the development of more modern and advanced systems of trade and apprentice training. (1962, p16)

Massed or Distributed Practice

Massed or continuous practice implies that a skill or operation is practised over and over again in the one session until proficiency is attained. Distributed or spaced practice on the other hand means that practice is spread over a number of shorter practice sessions interspersed with a change of activity or rest periods. A student called on to continually practise taking measurements with the micromotor until proficiency was reached would be using the massed method of practice. A student who practised on the micromotor for short periods after each machining operation could be thought of as using the spaced method.

It is generally agreed that the distributed method of practice is superior to the massed method for both acquisition and retention. Although the exact length of the practice session must depend on the nature of the skill, for the most part, says Gorman, "relatively short practice sessions over a longer period of time result in more effective learning than longer practice sessions over a shorter period of time". (1974, p354)

In the previously referred to experiment reported in Klausmeier & Goodwin, involving the learning of Morse Code, the author had one group of learners practise for four(4) hours daily over eight(8) weeks instead of the usual seven(7) hours daily over five(5) weeks. He found that the four hour group was as good as the seven hour group at the end of five weeks, despite the shorter hours of practice, and they still had three more weeks to practise. (Klausmeier & Ripple, 1971, pp509-510)

Klausmeier and Ripple also report that equally significant results in favour of distributed practice have been obtained for skills such as typing, learning to juggle, high speed perceptual motor tasks and simple manual skills (1971, p511). They go on to say that while the proper length of practice sessions and proper intervals of rest must depend on the nature of the task and the characteristics of the learners, the conclusion nevertheless is clear:

> Distributed practice produces excellent results when the practice sessions are long enough to bring about improvement and when the time between sessions is long enough to overcome fatigue but not so long that forgetting occurs. (1971, p512)

In fact, Gagne points out that even with massed practice, the depressing effects tend to be confined to the performance at the time of the practice and that the level of performance of learners given massed practice will often recover following a rest and rise to the level of those given distributed practice. (1971, p227)

The implications seem clear. It would appear that when a teacher has to teach a potentially boring and repetitive task or exercise such as filing, typing, welding, lead burning, etc., continuously in a learning session, he would do well to plan the practice sessions to include various intervening rest or break activities. This would serve to avoid the learner fatigue and lowered motivation and depressed performance often associated with massed or continuous practice.

When called on to teach a more complex and potentially interesting task, on the other hand, such as the construction of a cabinet, it would appear that massed or continuous practice would be quite efficient as this type of task really involves spaced practice on a number of different component operations.

ACTIVITIES AND QUESTIONS FOR DISCUSSION

7. Return to Class Exercise 1

   a) Try the exercise again using spaced practice. eg. Take a one minute rest between each of the ten practice trials.

   or

   b) Try the exercise again using the part method of practice. eg. Divide the alphabet into two parts: A-M; N-Z. Practise writing the second half backwards for 4 trials; the first half backwards for 4 trials; then the whole alphabet for 2 trials.

   Record the results of your performance over 10 trials graphically. Describe your pattern of performance and compare it with your first performance on Exercise 1. (2 marks)

8. Describe an experiment which has investigated the effects of methods or schedules of practice on the learning of psychomotor skills. Explain the implications of the experiment for the teaching of psychomotor skills in TAFE. (Acknowledge all references used). (2 marks)

V MOTIVATION

Underlying the whole process of learning psychomotor skills is the question of motivation. Students will practise more conscientiously, try harder to improve, watch the demonstration more attentively, respond to the feedback more willingly, strive to reach a good standard on the whole skill, etc, if they are motivated to do so. That is, if they want to do so and see a reason to do so.

It is not the purpose of this booklet to outline the various theories and factors involved in motivation. Nor is it the intention to attempt any review or summary of the countless research studies which have examined motivation. These issues are tackled in another module.

On the basis of this research though and related ideas and theories, a number of practical suggestions may be made concerning the most effective motivational techniques to apply in the practical classroom and workshop. These are summarised below.

1. General

   Use a variety of motivating techniques such as personal goals, practical value of skill or task, individual needs and interests, variety and intrinsic motives such as curiosity, involvement and discovery.

2. Curiosity

   Provoke curiosity and interest by pointing to a problem or difficulty. Ask how the task is to be completed or the operation to be carried out.

3. Attention

   Arouse attention by starting with something novel or different. Show positive examples of the finished job or negative examples of common errors. Maintain interest by varying the practice method or task.

4. Level of Aspiration

   Provide for different levels of aspiration by encouraging levels of performance and goals in keeping with students' abilities. Set standards which are within reach but still offer challenge.

5. Achievement Motivation

   Increase levels of achievement motivation through example, encouragement, competition, positive comments, etc.

6. Feedback

   Use praise, encouragement, feedback and review as often as possible - particularly for slow learners. Acknowledge success and give personal, positive and informative knowledge of results as well as grades for work completed.

(Based on Gorman, 1974, pp140-141)

ASSIGNMENTS

ASSESSMENT FOR THIS MODULE SHOULD BE BASED ON THE FOLLOWING ASSIGNMENTS.

PART A

Present written answers for the Activities and Questions for Discussion within this module (numbers 1, 2, 3, 4, 5, 6, 7, 8) (Reduce to 10 marks)

PART B

Present written answers to the questions for discussion on Class Exercise 1 OR Class Exercise 2. (see Appendix) (10 marks)

Total: 20 marks

Note

Assignment answers should reflect a consideration of some of the references given in this module. References used should be acknowledged in the body of the assignment and a full bibliography provided at the end.

REFERENCES AND FURTHER READING

BASIC

AUSUBEL, D P, NOVAK, J D and HANESIAN, H. Educational Psychology: A Cognitive View. 2nd edn, Holt, Rinehart and Winston, New York, 1978, Ch 10.

AUSUBEL, D P and ROBINSON, F G. School Learning: An Introduction to Educational Psychology. Holt, Rinehart and Winston, New York, 1969, Ch 10.

BIEHLER, R F. Psychology Applied to Teaching. Houghton, Mifflin Co, Boston, 1971; 1974.

CRONBACH, L J. Educational Psychology. Harcourt Brace & Co, London, 1961, Ch 12; 1977.

DAVIS, R H, ALEXANDER, L T and YELON, S L. Learning System Design. McGraw Hill, New York, 1974, Ch 11.

DE CECCO, J P and CRAWFORD, W R. The Psychology of Learning and Instruction. 2nd edn, Prentice Hall, New Jersey, 1974, Ch 9.

GAGE, N L and BERLINER, D C. Educational Psychology. Rand McNally, Chicago, 1st edn, 1975, Unit 30, pp 715-733; 2nd edn, 1979, Ch 19, pp 442-430.

GAGNE, R M. The Conditions of Learning. 3rd edn, Holt, Rinehart and Winston, New York, 1977, Ch 9.

GORMAN, R M. The Psychology of Classroom Learning. Merrill, Columbus Ohio, 1974, Ch 13.

JOHNSON, D W. Educational Psychology. Prentice Hall, Englewood Cliffs, New Jersey, 1979, Ch 8, pp275-280, Ch 9.

JONES, A and WHITTAKER, P. Testing Industrial Skills. Gower Press, Essex, UK, 1975, Ch 2.

KLAUSMEIER, H J and GOODWIN, W. Learning and Human Abilities: Educational Psychology. Harper & Row, New York, 1966, Ch 9.

KLAUSMEIER, H J and RIPPLE, R E. Learning and Human Abilities: Educational Psychology. 3rd edn, Harper & Row, New York, 1971, Ch 13.

KLAUSMEIER, H J. Learning and Human Abilities: Educational Psychology. 4th edn, Harper & Row, New York, 1975, Ch 13.

MILLS, N R. Teaching and Training: A Handbook for Instructors. 2nd edn, MacMillan, London, 1972, Ch 7.

MORGAN, C T and KING, R A. Introduction to Psychology. 3rd edn, McGraw-Hill, New York, 1966.

MORSE, W and WINGO, M. Psychology and Teaching. 3rd edn, Scott Foresman, Glenview, Ill., 1969, pp231-241.

MUNN, N L. Psychology. 4th edn, Houghton-Mifflin, New York, 1961.

ROGERS, J. Adults Learning. Penguin Education, Harmondsworth, 1973, Ch 3.

STEPHENS, J M. Educational Psychology. Holt, Rinehart and Winston, New York, 1956, Ch 10, pp 317-323; Ch 11, pp330-340.

ADVANCED

BRAVERMAN, B B and De CARO, J J. 'A Review of the Literature on Psychomotor Skill Development: Implications for the Teaching of Machine Use Skills', Journal of Industrial Teacher Education, Vol. 16, No. 4, Summer 1979, pp5-18.

FITTS, P M. 'Factors in Complex Skill Training', in Kuhlen, R G (ed), Studies in Educational Psychology, Blaisdell Publishing Co., Waltham, Mass., 1968, pp390-404.

FITTS, P M. 'Perceptual Motor Skill Learning', in Melton, A W (ed), Categories of Human Learning, Academic Press, New York, 1964.

HOLDING, D H. 'Knowledge of Results', in Legge, D (ed), Skills, Penguin, Harmondsworth, 1970, Ch 19.

HOLDING, D H. 'Guidance', in Legge, D (ed), Skills, Penguin, Harmondsworth, 1970, Ch 20.

LOVELL, R B. Adult Learning. Croom Helm, London, 1980, Ch 5.

MEDNICK, S A. Learning. Prentice-Hall, Englewood Cliffs, New Jersey, 1964.

O'HARA, J B. 'Training for Complex Skills', Personnel Practices Bulletin, Vol 18, No 1, March 1962. (reprint in Xerox File).

PETERSON, L R. Learning. Scott Foresman & Co., Glenview, Illinois, 1975, Ch 7.

APPENDIX

Class Exercise 1: 'The Effects of Practice on the Performance of a Simple Skill'

Class Exercise 2: 'The Effects of Knowledge of Results on the Performance of a Simple Skill'

DIPLOMA OF TEACHING (TECHNICAL)

EDUCATIONAL PSYCHOLOGY

CLASS EXERCISE: THE EFFECTS OF PRACTICE ON THE PERFORMANCE OF A SIMPLE SKILL

INTRODUCTION

Among the more satisfactory definitions of learning is that which defines it as the modification of behaviour through experience. This exercise is designed to illustrate learning as the modification of performance on a skill due to practice. The skill is writing the alphabet backwards.

PROCEDURE

An accompanying page is divided into ten columns. When instructed 'Go', write the letters of the alphabet backwards in a vertical column from top to bottom. DO NOT SACRIFICE ACCURACY FOR SPEED. You will be allowed 20 seconds to write as many letters as you can for each trial. If you complete the alphabet, on any trial, stop and wait for the next trial. As soon as instructed 'Stop', fold the paper under along the vertical line. This procedure will continue for ten trials. DO NOT WRITE THE ALPHABET FORWARDS AT ANY TIME WHILST THIS EXPERIMENT IS ON.

TREATMENT OF RESULTS

1. Count the number of correct letters on each trial. You are correct only until you make an error. Letters after the first error do not count to your score.

2. Tabulate your results below in the column marked Individual Score. (Tabulate group average scores if time).

3. On the grid supplied, plot a learning (performance) curve for yourself and one for the group as a whole (if time). Indicate which is which.

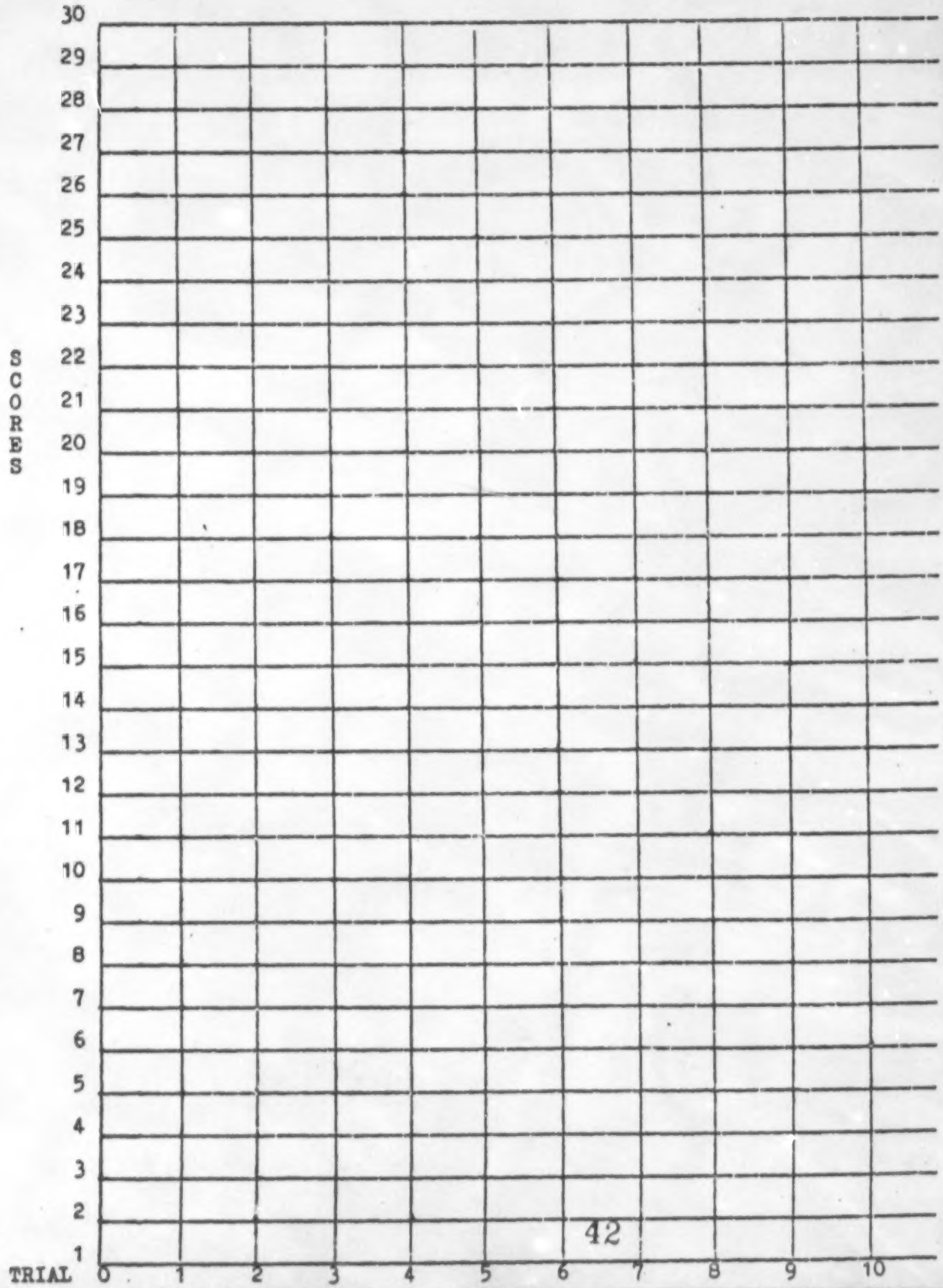
TABLE: INDIVIDUAL AND GROUP RESULTS

Trial	Individual Scores	Group Average Scores
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

WORK SHEET

TRIAL NUMBER	1	2	3	4	5	6	7	8	9	10
NUMBER CORRECT										
TRIAL NUMBER	1	2	3	4	5	6	7	8	9	10

LEARNING CURVES



QUESTIONS FOR CLASS DISCUSSION AND WRITTEN COMMENT

1. Did your overall performance (as revealed by your performance curve) show:

   a. decreasing returns for practice;
   b. increasing returns for practice; or
   c. equal returns for practice.

   And was any other eventuality revealed by the curve, eg. plateau, decline, etc?

   (NB. To answer the first part of this question it is necessary to draw a smooth curve to represent your overall performance from trial 1 to trial 10).
   (2 marks)

2. What does your performance curve indicate about the rate of your improvement in performance over the 10 practice trials? (2 marks)

3. Give two reasons to account for your pattern of performance. (2 marks)

4. Describe four procedures for classroom or workshop which a teacher might adopt to improve the effectiveness of practice in his school. Illustrate each procedure with an example from your own teaching field. (4 marks)

Optional Question

Describe the average performance of the group as represented by the group performance curve. Compare group average performance with your performance.

REFERENCES

BIEHLER, R F. Psychology Applied to Teaching, Houghton, Mifflin, 1971, Ch 8, 279-292; 1974.

DE CECCO, J P and CRAWFORD, W R. The Psychology of Learning and Instruction, 2nd edn, 1974, Ch 9, 245-264, 272-284.

KLAUSMEIER, H J and GOODWIN, W. Learning and Human Abilities, 2nd edn, 1966, Ch 9, 320-338.

KLAUSMEIER, H J and RIPPLE, R E. Learning and Human Abilities: Educational Psychology, 1971, Ch 13, 502-515.

MILLS, N R. Teaching and Training: A Handbook for Instructors, 2nd edn, MacMillan, 1972, Ch 7.

ROGERS, J. Adults Learning, Penguin, 1973, Ch 3, 64-73.

STEPHENS, J M. Educational Psychology, 1956, Ch 10, 317-323.

(And see References and Further Reading for booklet: Learning Psychomotor Skills in TAFE)

DIPLOMA OF TEACHING (TECHNICAL)

EDUCATIONAL PSYCHOLOGY

CLASS EXERCISE: THE EFFECTS OF KNOWLEDGE OF RESULTS ON THE PERFORMANCE OF A SIMPLE SKILL

AIM

To examine the effects of knowledge of results on the performance of a skill: hitting the bulls eye on a target while blindfolded.

PROCEDURE

Each subject will endeavour to hit, with his pencil, the bulls eye on a target while blindfolded. The target is on the desk in front of the firer and each subject will fire 20 shots.

Group A will fire 10 shots with no knowledge of results, followed immediately by 10 shots with knowledge of results.

Group B will reverse this procedure.

Individual scores on each trial will be tabulated by the scorers.

Individual and group and total means will be calculated and tabulated.

Individual learning or performance curves will be studied and the differences between the means examined.

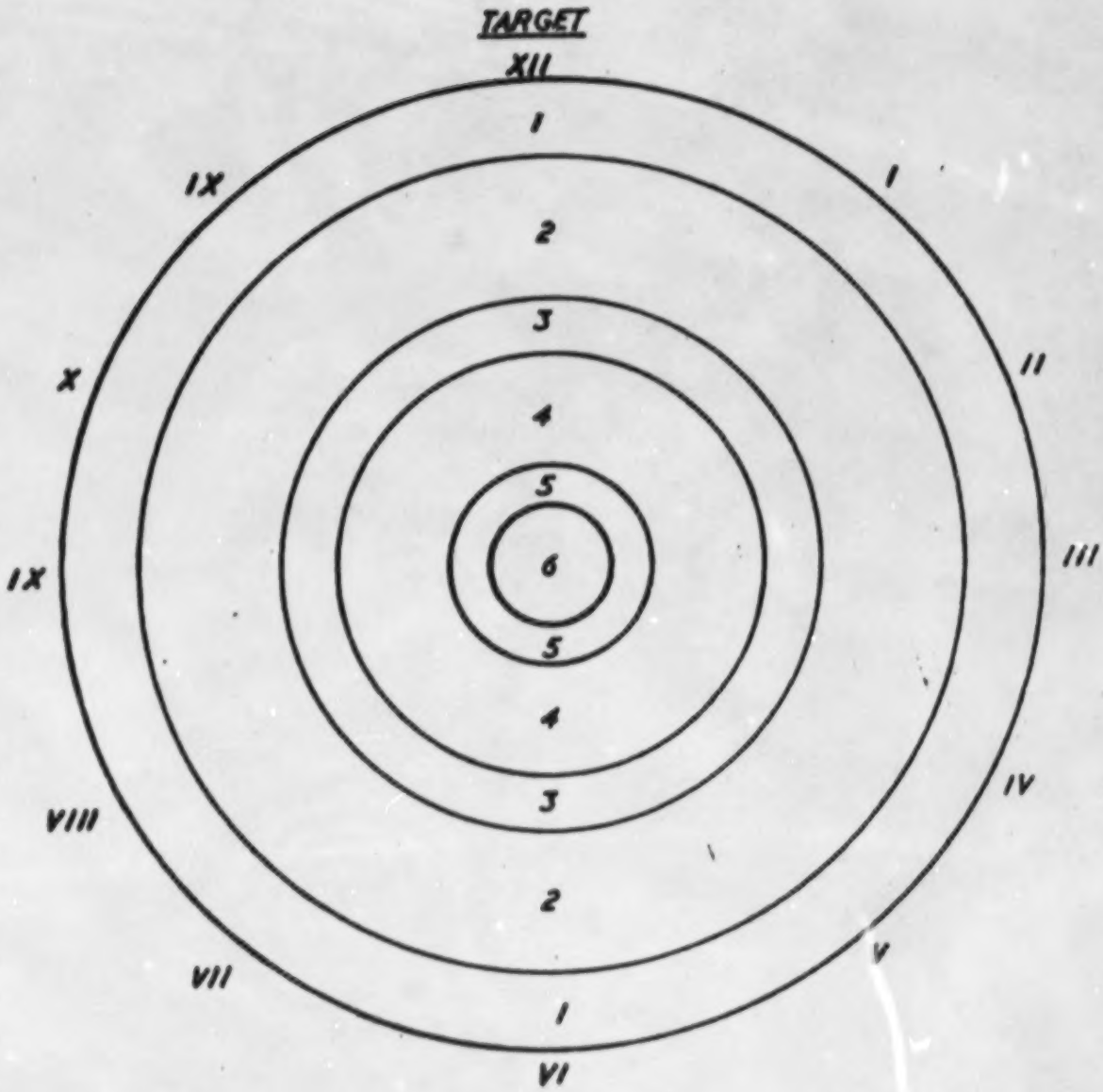
NOTE: Procedure When Firing. Subject must have a shot, return hand to starting place, and do nothing else.

CONDITIONS

Under the Knowledge of Results Condition: The experimenter tells the subject when to fire, and the results of the shot (score from 0-6 and direction in terms of clock face). He then enters the result for the shot in the appropriate space and column on the subjects result table. (Score only)

Under the No Knowledge of Results Condition: The experimenter tells the subject only when to fire. (However, he still enters the result of each shot on the subject's result sheet).

NB. Make sure the name of the subject, (the firer) is on his/her result sheet.


TARGET
XII
I
II
III
IV
V
VI
VII
VIII
IX
X
IX
1
2
3
4
5
6
5
4
3
2
1

RESULTS SHEET

INDIVIDUAL RESULTS

(Score 0-6 - Not Direction)

TRIAL	WITH KNOWLEDGE OF RESULTS	NO KNOWLEDGE OF RESULTS
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total		
Mean		

GROUP RESULTS

Group A - Procedure 1

No Knowledge of Results FOLLOWED BY Knowledge of Results	Mean Score for	
	Knowledge of Results	No Knowledge of Results

Group B - Procedure 2

Knowledge of Results FOLLOWED BY No Knowledge of Results	Mean Score for	
	Knowledge of Results	No Knowledge of Results

TOTAL SCORES FOR THE TWO GROUPS

Mean Score for	
Knowledge of Results	No Knowledge of Results

QUESTIONS FOR DISCUSSION AND WRITTEN COMMENT

1. a. In this exercise, did practice with knowledge of results lead to generally better overall performance, than practice with no knowledge of results? Why does the provision of knowledge of results generally lead to improved performance?

   b. Was this effect as noticeable for both orders of procedure, and if not, why not? (3 marks)

2. Construct two performance curves tracing your performance under the two practice conditions (or one combined curve showing this performance). What do these curves indicate about your performance when practising:

   a. with knowledge of results?
   b. with no knowledge of results?
   (Indicate whether you were in Group A or B.) (1 mark)

3. Outline two points of significance which can be drawn from this exercise, relating to the teaching of skills. Illustrate each point with an example from your teaching field. (2 marks)

4. Describe two other ways a student can receive knowledge of results during practice apart from direct correction and supervision (telling) by the teacher. (1 mark)

5. Write half to a full page describing the feedback strategies you would use to teach a skill in your school. Emphasise the types of intrinsic feedback to be used and the means by which the shift from augmented to intrinsic feedback would be made. Make reference also to the place of immediate Vs delayed reviews, and the place, if any, of partial feedback (feedback after every 3rd or 4th trial). Make use of references and supporting studies if you can. (3 marks)

OR

6. Write half to a full page describing three motivational strategies you would use to teach a skill in your school. Make use of references and research studies and examples to support your ideas. (3 marks)

REFERENCES

BIEHLER, R F. Psychology Applied to Teaching, 1971, Ch 8, 281-292; 1974.

CRONBACH, L J. Educational Psychology, 1961, Ch 12, 360-363.

DE CECCO, J P. The Psychology of Learning and Instruction, 1968, Ch 8, 290-295.

DE CECCO, J P and CRAWFORD, W R. The Psychology of Learning and Instruction, 2nd edn, 1974, Ch 9, 259-264.

GORMAN, R M. The Psychology of Classroom Learning, 1974, Part 3.

KLAUSMEIER, H J and GOODWIN, W. Learning and Human Abilities: Educational Psychology, 2nd edn, 1966, Ch 9, 321-337.

KLAUSMEIER, H J and RIPPLE, R E. Learning and Human Abilities: Educational Psychology, 1971, Ch 13, 477-483, 513-514.

MEDNICK, S A (et al). Learning, 2nd edn, 1973, Ch 3, 321-337.

STEPHENS, J M. Educational Psychology, 1956, Ch 11, 301-302, 330-340.

(And see References and Further Reading for booklet: The Learning of Psychomotor Skills in TAFE).